Chukchi-Beaufort Seas High-Resolution Atmospheric Reanalysis (CBHAR): Data Verification and Climate Analysis

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INTRODUCTION

- Global models are the most widely used tools to generate various reanalysis data. However, coarse resolution limits their capability to capture detailed synoptic and mesoscale weather systems and the associated heterogeneous distribution of weather elements.
- Regional models are commonly utilized to better represent local weather systems, benefiting from higher-resolution grids and regionally-optimized model configurations.
- In this study, the state-of-the-art regional model Weather Research and Forecasting (WRF) and its three dimensional variational (3DVAR) data assimilation system WRF-3DVAR was applied to the Arctic marginal ice zone along the northern Alaska Coast for producing high-resolution regional reanalysis.
- Potential oil development exists in the study area, thus the high-resolution reanalyzed surface winds will provide a better understanding of regional and local surface circulation patterns, which are the primary driver of oil spill movement should the spill disasters happen.

MODEL CONFIGURATION

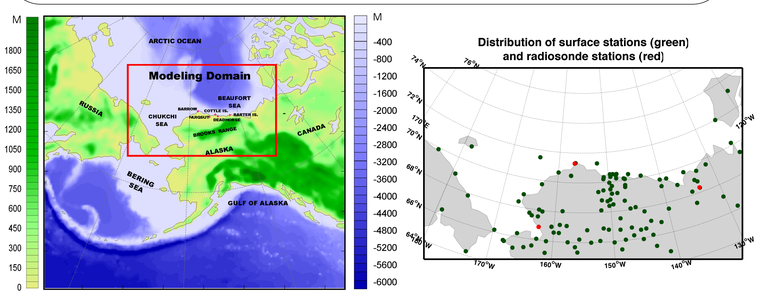
Model Domain (red box)
- 10 km grid spacing
- 49 vertical levels

Optimized Physics Options
- Morrison microphysics
- RRTMG radiation
- MYJ PBL
- Noah LSM
- Kain-Fritsch cumulus

Nudging & Assimilation
- Spectral nudging to ERA-I
- 3-hourly assimilation

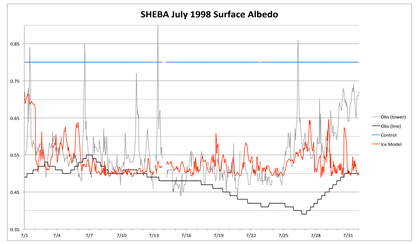
Data assimilated:
- Surface obs (T, RH, SLP, Winds)
- Radiosondes (T, RH, Winds)
- QuikSCAT SeaWinds
- MODIS profiles (T, RH)
- AVHRR/MODIS Polar Winds

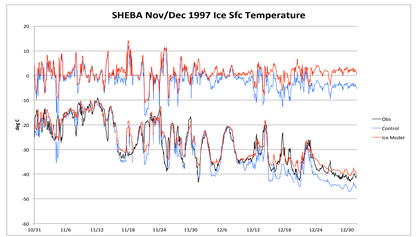
Forcing Data
- ERA-Interim (ERA-I) global reanalysis (0.7° grid)
- Daily Canadian Meteorological Centre (CMC) snow depth
- Daily AMSR-E sea ice concentration / thickness



OPTIMIZATION OF WRF-3DVAR MODELING SYSTEM FOR STUDY AREA

Coupling of a thermodynamic sea model produces seasonally accurate surface albedo even during the difficult-to-model melting season. As a result, the strong cold bias in ice surface temperatures by WRF-NOAH land surface model has been corrected

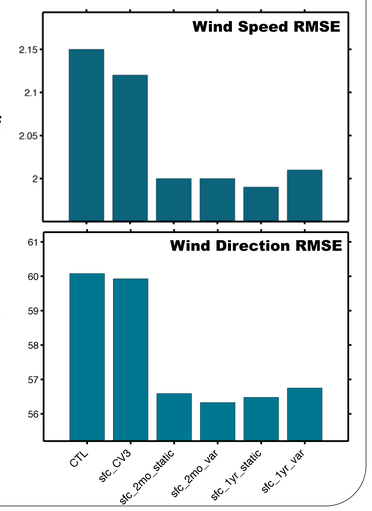




Assimilation experiments analyzing the sensitivity of WRF-3DVAR to model background errors (BE)

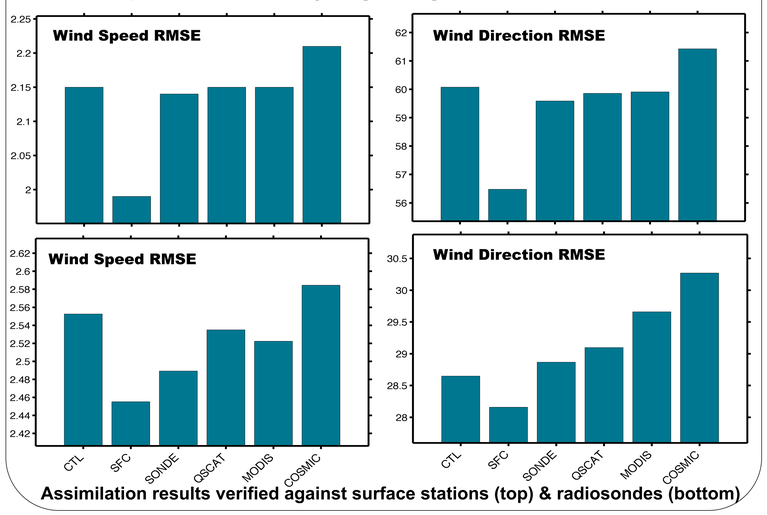
CTL	Control (no assimilation)
Sfc_CV3	Global BE (default)
Sfc_2mo_static	Custom BE from 2-month period
Sfc_2mo_var	Custom BE from 2-month period w/ diurnal
Sfc_1yr_static	Custom BE from 1-year period
Sfc_1yr_var	Custom BE from 1-year period w/ diurnal

Customized BEs outperformed the global BE, demonstrating the importance of using BE customized for a particular area in regional data assimilation. There was little difference among the custom BE runs, suggesting the consistency of model bias throughout time.



Using WRF-3DVAR with customized background error, assimilation of surface stations, radiosondes, QuikSCAT ocean winds, and derived temperature and moisture profiles from MODIS and COSMIC instruments were tested to identify those that improved results.

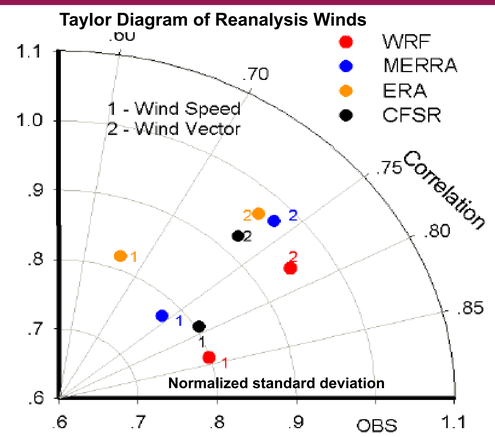
Surface stations showed the greatest positive impact on model winds, both at the surface and aloft. Radiosondes also improved the reanalysis, while satellite products had weaker impacts, with COSMIC profiles noticeably degrading the simulation.

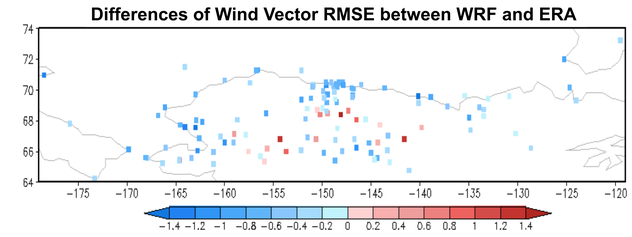


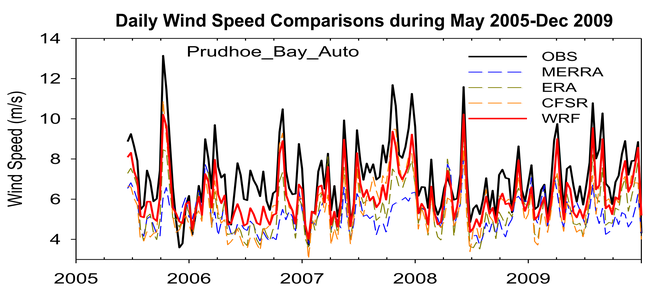
Assimilation results verified against surface stations (top) & radiosondes (bottom)

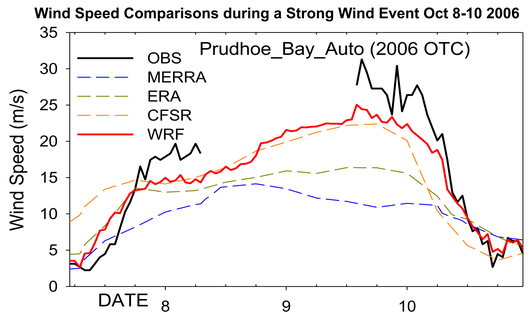
5-YEAR EXPERIMENTAL REANALYSIS

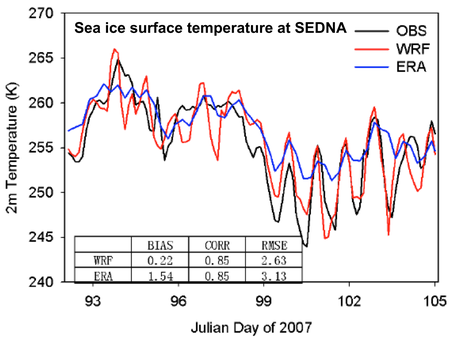
High-Resolution Regional Reanalysis Showing Better Agreement with Observations!











	BIAS	CORR	RMSE
WRF	0.22	0.85	2.63
ERA	1.54	0.85	3.13

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